

JUNE 1, 1919

PRICE 25 CENTS

AVIATION

AND
AERONAUTICAL ENGINEERING



The New Army Airship A-4 at its Trials

VOLUME VI
Number 1

SPECIAL FEATURES

DEVELOPMENT OF THE NC SEAPLANES
NAVAL AIRSHIP C-5 MAKES 1100-MILE FLIGHT
COURSE IN AERODYNAMICS AND AIRPLANE DESIGN
VENEER BODY CONSTRUCTION
CHART FOR PERFORMANCE COMPUTATIONS

Three
Dollars
a Year



PUBLISHED SEMI-MONTHLY
BY
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HARTFORD BUILDING, UNION SQUARE
22 EAST SEVENTEENTH STREET, NEW YORK



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This flight, briefly described in the attached letter should prove intensely interesting to everyone interested in aerial transportation.

Bulletin describing the Hall-Scott L-4 or L-6 Airplane Engines needed upon request.

HALL-SCOTT MOTOR CAR COMPANY

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HALL-SCOTT



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May I trouble you to accept my congratulations on your first flight of
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The up and coming mail and
express service of my company is steadily
growing and we have made half way
on the account. I expect to return
to day to our new office at 6245 with 48
L-4. The mail will be sorted free.

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W. L. Whitney

W. L. Whitney
Post Master
Berkeley, California
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Aeromarine



Sales
Department
Times Bldg
New York

The experimental age of the airplane has been passed. With its part in the war now a bright epoch in history, the airplane is going to create history in the world of commerce.

Factory
Keppan
New Jersey

A black and white photograph showing a large stack of wooden propellers in the background, with a single Hartzell Walnut propeller in the foreground. In the top right corner of the image, there is a circular emblem with the word "LIBERTY" around the perimeter.

Why Walnut is Better Than Other Woods for Airplane Propellers

THIS is a question of vital importance to the aviator whose life depends upon the reliability of his propeller. The fact that walnut is better than other woods for propellers is an established fact, recognized by all authorities on the subject. The reasons why it is superior are not always so clearly understood by the users of propellers. **THREE PRINCIPAL REASONS FOR THE SUPERIORITY OF WALNUT ARE AS FOLLOWS:**

1. Walnut is very light and has great strength and shock resisting qualities.
2. Walnut is the most substantial and most durable cabinet wood known as the wood-working industry.
3. Properly dried walnut will never shrink, warp or twist after it has been manufactured into a propeller.

Write us for catalog and further information on Walnut Propellers, complete from the log to the finished propeller blade. If a design propeller is sent we will match it.

HARTZELL WALNUT PROPELLER CO.,
PEORIA, ILLINOIS



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The Secret of NON-GRAN

"We had some castings made to your formula," said the Purchasing Agent, "but our Engineering Department reports that they don't stand up like Non-Gran. What do you put into your material that makes it so everlastingly durable?"

"It is all in the foundry practice," replied the Non-Gran salesman. "The process of alloying and casting Non-Gran is the result of two years' special work on this one alloy. No other metal ever gives you such a foundry."

"The fundamental reason for the superiority of Non-Gran is that it is made to meet a quality ideal. We do not sacrifice quality to meet price. Non-Gran is bought by manufacturers who recognize the assurance against bearing troubles that Non-Gran provides."

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"We safeguard our customers' interests by making sure that every Non-Gran Bearing has the same superior quality."

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American Bronze Corporation
Bryn Mawr
Pennsylvania

HIGH SPEED
NON-GRAN
LEADERS BRONZE

OLMSTED PROPELLERS



The C. M. O. Physical Laboratory, Inc., Buffalo, N. Y., presents the following advertisement concerning the unique propellers, which because of high efficiency were selected by the Navy for the trans-Atlantic NC boat.

DESIGNER, Charles M. Olmsted, A.B., A.M., Harvard, Ph.D. Univ. of Bonn; formerly a physicist of the Carnegie Institution of Washington, now president of the C. M. O. Physical Laboratory, Inc.

DIFFERENCE: The basic underlying theory, according to which the radial distribution of blade surface and angle is determined, is original with Dr. Olmsted, and the resulting blade is much wider at the base and narrower at the tip than standard practice.

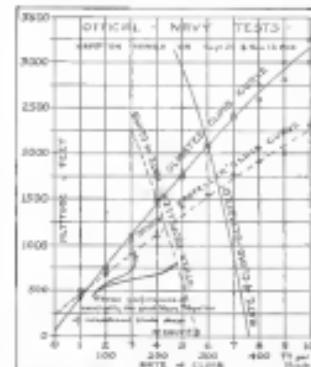
This is clearly seen in the above photograph of the Navy trans-Atlantic hydro-aeroplane equipped with Olmsted propellers.

ADVANTAGE: Olmsted propellers invariably hold the motor to within a few per cent of the predetermined revolutions and deliver at these revolutions a greater flying thrust than is attainable with any other blade.

TESTS: Numerous official Army and Navy tests have invariably proved that the Olmsted type of blade is more efficient than the most skillfully designed and constructed blades of the type now in common use. We print herewith curves made from the figures of a recent official Navy test. Notwithstanding the fact that the Olmsted propeller increased the climb in ten minutes by 52% while holding the motor to exactly the same revolutions, the same propeller also increased the maximum horizontal speed several miles per hour.

PATENTS: The Olmsted type of blade is fully covered by U. S. and foreign basic form patents which are owned by

THE C. M. O. PHYSICAL LABORATORY, INC., BUFFALO, N. Y.





UNION GAS ENGINE CO. OAKLAND CALIFORNIA

JUNE 1, 1919

AVIATION AND AERONAUTICAL ENGINEERING

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AEROPLANE CRANKSHAFTS

WYMAN-GORDON HIGH DUTY CRANKSHAFTS did their full duty in Aeroplane Motors used by the United States and Allied Nations.

We are justly proud of our contribution to the General Aeronautical Program.

WYMAN-GORDON COMPANY

The Crankshaft Makers
Worcester, Mass.

Cleveland, Ohio

Quality

SHOWING a few of the factory report forms used in the testing, checking, gauging and inspection systems by which New Departure quality is persistently maintained.



New Departure Ball Bearings

A. D. KLEINER
PRESIDENT AND CHIEF
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VICE-PRESIDENT
W. J. WILSON
GENERAL SECRETARY
H. H. WILLIAMS
GENERAL MANAGER

AVIATION AND AERONAUTICAL ENGINEERING

Vol. VI

June 1, 1939

No. 2

THE keenest interest which attended the progress of the NC Seaplane, Dragon I in its flight to the Azores, and which was earned only in part by the fact it is a testing instrument to the professional skill of our naval aviators as well as to the worth of American airplane construction.

While Commander Read carried off the laurels for short flying performance by making a 1,200-mile nonstop flight from Trepassey to Horta, Commander Tamm's successful sailing of his disabled seaplane for two days in heavy seas and storms is an achievement that deserves a place of its own in the annals of aviation. This surface course of 200 miles brilliantly shows up the seaworthiness of the large boat-type seaplane, originated and developed by Glenn H. Curtiss and the great possibilities for ocean travel, while it sheds a new light on the grit and resourcefulness of the United States Navy.

While Commander Bellinger has done unspeakable in his attempt to reach the Azores with the N.C., his flight, which ended but 100 miles off the goal, is evidence of the excellence of the Liberty engine, which worked faithfully on all the three seaplanes.

Hoover and Gruve

The unprecedented attempt of Harry G. Hoover and Commander Mackenzie Gruve, R. N., to win for Great Britain the Blue ribbon of the transatlantic flight is a tale of heroism which will be nobly preserved upon the rolls of honor of the British air service of tomorrow.

To attempt to cross 2,000 miles of ocean without slighting in a land machine demands more than ordinary determination and endurance; therefore the news that the two gallant Britons have been rescued after hope had almost deserted as to their chance of survival will come universal rejoicing.

The Flight of the C-5

The extreme value of the United States naval airship C-5 affords a highly instructive object lesson to all those concerned with the development of lighter-than-air craft.

On the one hand, we have the outstanding fact of an American-built and American-manned airship of comparatively small size—100,000 cu. ft.—working under most adverse weather conditions a nonstop cruise of 1,100 miles and reaching its destination according to plan, which demonstrates that the airships of the United States Navy are, within their class, second to none.

On the other hand, the unfortunate loss of the C-5 serves to indicate that the problem of soaring an airship in a wind-swept area has not been fully solved as yet.

The three-point ground anchorage for seaplanes, which failed at Newfoundland, assures its purpose under average weather conditions, and has the merit of low cost and ease of assembly. But in a gale this seaplane puts the envelope and rigging of a seaplane to an unyielding strain because the wind impinges upon the seaplane tangentially instead of axially; this gives, furthermore, rise to a lifting component which varies with the strength of the wind and therefore causes longitudinal oscillations. In other words, the airship pitches on its nosecone, with the ensuing risk of having the envelope damaged if the wind be strong enough.

Experiments carried out already lead to the conclusion that stability on the seaplane can best be overcome by the use of rousing nests provided with a canvas cap, to which the seaplane fastens her nose and then swings freely with the wind. Of course, reinforced rear spar reinforcement on the nose, but otherwise no special reinforcement on the nose, but otherwise this solution appears extremely simple and workable; it has in fact given remarkable results abroad; some ships thus avoided having extruded winds of 50 m. p. h. The development of a mooring mast, built in sections so it could be easily transported, assembled and taken down again, therefore seems to demand the immediate attention of airship constructors.

The Air Mail Service

The first annual report on the operation of the air mail service between Washington and New York, which has just been made public by the Post Office Department, is a document of more than passing interest and its perusal is well worth the time of all those interested in the development of commercial aeronautics.

The outstanding features of this report are: that out of a possible 238,210 miles there were flown 129,255 miles, that is, a performance of 53.22 per cent.; that out of 3,293 trips only 35 were not undertaken or failed for various reasons—a deficit of only 4.4 per cent.; that during these twelve months there have been only thirty-seven forced landings; that the six airships which entered upon this service a year ago now, with the same engines, still in commission, rendering estimations unsafe, that there has occurred no single fatal accident and only two serious and six light injuries in flying operations; and finally, that the balance sheet of the service shows a net surplus of over \$10,000.

The record of the air mail not only bears testimony to the careful and efficient manner in which the service has been operated by Ben. Otto Prager and his associates; it also proves beyond dispute that the era of aerial transport has truly arrived.

ALEXANDER KLEINER
GENERAL EDITOR
LAWRENCE STOUT
ASSISTANT EDITOR
GEORGE NEWFIELD
BUSINESS MANAGER

Development of the NC Seaplanes

The history of the inception and development of the NC seaplanes, with additional information on some of their distinctive construction features and equipment, has been made public by the Navy Department and is printed herewith on part.

Full description of the NC type of seaplane dates from Aug. 27, 1912, when Rear-Admiral David W. Taylor, Chief Constructor of the Navy, suggested in a memorandum to Naval Constructor J. C. Richardson, U. S. N., his opinion that "necessitating the development of a large flying boat, the NC would be able to fly across the ocean." This was to be able to fly across the ocean (the sea) in any weather, and also be able to fly across the

pedimentary studies prepared on the losses and, prepared that the design have a short hull, with a flat bottom that slopes to the water on outriggers. This plan was adopted, in view of the greater maneuverability, weight-saving, and ease of the hull.

Plans were then prepared on the hulls for a boat of the character to be fitted with three engines, and the results



Front and Middle Portions of the NC-1 Flying Boat. (Courtesy of the Bureau of Navigation.)
Photo: Naval Bureau.

afforded to meet difficulties of delivery, and when the releasing means should be shaped, etc. of not destroyed, from the air." Attention was called in this memorandum to the fact that the Liberty engine gave good promise of being a very strong workhorse, and formed a satisfactory power plant for these seaplanes.

Studies were immediately undertaken by the Bureau of Naval Construction and Repair, to apply the Liberty engine to a large seaplane.

Admiral Taylor, after a study of the problem, directed the Bureau of Naval Construction to draw in a preliminary way the size and nature of a design of large flying boat to combine the necessities of seaplanes equipped with sufficient endurance to fly across the Atlantic, to the satisfaction of the operating bureaus. France and England, to be used as a flying boat to be used as a long-distance air mail carrier covering every angle of the globe. It was anticipated that the boat would be utilized in the air by enemy aircraft.

Planning of Plans

On Sept. 15, 1912, Glenn H. Curtiss was requested by the Bureau of Construction to draw the plans of the NC flying boat, and to submit the same to the Bureau of Naval Construction. On the following day, Mr. L. Orman and Shirley Kiesler, Mr. Curtiss and his engineers went over the

sketch with Mr. Orman. The predicted performance was estimated for each boat, from which it appeared that the three engine boat would be able to endure a general maneuvering of the planform, and to endure a general maneuvering and make use of fuel. Admiral Taylor, accordingly directed that the design staff of the Bureau be put on the job of the three-engine type. Investigations were at once undertaken to determine in a preliminary way the dimensions of such boats, after which the general dimensions, etc., and the materials to be employed for required parts. The plan and appearance of the design was worked out, and the plan thus established to be followed in making the detailed drawing.

Wind Tunnel Tests

At three boat models of the design was then made, and the models tested by Mr. A. F. Baldwin in the wind tunnel of the Washington Navy Yard. From his investigations of 100 flights on this model, when held in a vertical and an artificial wind, size and arrangement of tail-surfaces made to guarantee stability and correct balance. Flight tests were made on the model. As a result of these tests, it was determined that it was entirely necessary that there should be no deflection of the rudder, as an accident on the trial flights would

June 5, 1918

cause such a heavy loss of the hull, and for this purpose placed in charge, as its field representative, Naval Constructor U. L. McElroy, U. S. N., whose headquarters were at the plant of the Curtiss Aeroplane and Motor Corp., Buffalo, N. Y., where the initial design was begun at Buffalo, N. Y., on Dec. 1, 1912. Shortly after the commencement, Naval Constructor H. C. Richardson, U. S. N., was added for temporary duty in connection with the design of the hulls for the boats, and remained until the hulls were at the Naval Air station, Pensacola, Fla., to go to Buffalo.

Hull Design

The hull designed by this office was of novel form and construction, and embodied directly information obtained



Middle Portion of the NC-3.—Note the Change in the Mounting of the Wing Brackets.

It soon became apparent that the carrying on the the completion of design work of such dimensions at the Bureau of Construction and Repair, in Washington, would necessarily require an office at another place very near to the place of this work. Under the circumstances of air matters connected with the war which had developed upon this lesson, the decision with the other bureaus of the Navy Department, was entirely reasonable, and it was decided to arrange with the Curtiss Aeroplane and Motor Corp. at Buffalo, N. Y., to complete the designs with their own design facilities, and with the cooperation of themselves of such ability as might develop under the control and supervision of the Bureau of Construction and Repair.

Contract for Drawing

A contract was therefore made with the Curtiss Co. for the performance of this, the drafting and drawing work. Under the terms of this contract, Mr. Orman, to carry out all the work directed by the Navy Department, remaining in connection therewith all to three necessary. The Bureau of Construction and Repair reserved to itself the direction and oversight of all

work on behalf of the Bureau of Construction and Repair, and for this purpose placed in charge, as its field representative, Naval Constructor U. L. McElroy, U. S. N., whose headquarters were at the plant of the Curtiss Aeroplane and Motor Corp., Buffalo, N. Y., where the initial design was begun at Buffalo, N. Y., on Dec. 1, 1912. Shortly after the commencement, Naval Constructor H. C. Richardson, U. S. N., was added for temporary duty in connection with the design of the hulls for the boats, and remained until the hulls were at the Naval Air station, Pensacola, Fla., to go to Buffalo.

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for mounting of equipment weighs only 3,000 lb, yet the displacement is 26,000 lb, or one tenth of a pound of load per pound of displacement. This lightness of construction was attained by a careful selection and distribution of materials. The hull is of duraluminum, as is the plating. Longitudinal strength is given by a number of spars having wide stiffening webs. The transverse webbing is so arranged that, when there is a layer of insulation set in narrow glue between the two planks, the hull is

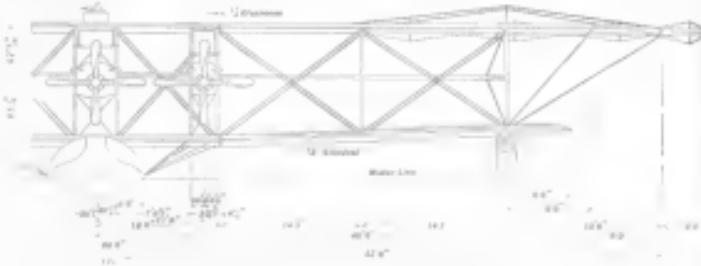
as strong as steel, or was designed to employ a spar stiffener of steel of 300,000 lb per sq in tensile strength. The engine bearing arms, bulkheads, and plates are made of large diameter hot forgings.

Tail Structure

The tail structure is built up on the form of a biplane and is supported by three hollow bronze tubes of steel cable to make it as light as possible. The arrangement of the wings is such that the tail is well balanced with the wings, so that the tail is not loaded when the wings are in the horizontal position. The total area of the tail surfaces is 100 sq ft, and the horizontal stabilizer has a total area of 200.6 sq ft, and the elevator, 240.3 sq ft. The total area of the three surfaces is 60 sq ft.

Wing Construction

The wings are of H. A. F. 6 curve and carry no load of the wings in the horizontal position, with the exception of the weight of the air. The construction is the same as the fuselage, using duraluminum and materials without materially increasing the weight.



FRONT ELEVATION OF THE NC 1 IN HORIZONTAL FLYING POSITION

and a great amount of research and experiment has been necessary to determine the best disposition of material to adopt.

The main wing spars are hollow spruce boxes. It is felt to be a truss design, like a bridge, consisting of continuous top strips of spruce corresponding to the upper and lower chords of a bridge truss, and together with an internal system of diagonal struts, form a rigid structure. The spars are made of spruce, but may be drawn out. On the first trials, the spars were required to support a load of 450 lb of sand per 24 in without damage.

An interesting detail of the wing construction is the forged leading edge which extends the entire surface to the airframe, or wing box. This eliminates the use of rivets and cables, and at the same time they are necessary for supports to carry, changing up the leading edge on its length.

The wings are arranged as a biplane with the necessary struts and wires to give great strength. For instance, the upper wing has a spanwise wire, which is a wire of 1/8 in diameter, and is so arranged that it is tensioned to a barreling of steel cable. This tensioning of the struts to have under load, the main spar post is connected with a steel cable. The diagonal bearing between the wings is by means of a steel cable or plates, with a strong form being used to reduce resistance.

Adhesives are used to the spar plates only and project 6 ft beyond the tips. Their total area is 260 sq ft.

The wing spars each weigh 95 lb and displace 3,800 lb.

The main wings when dried and stored are assumed to have a specific gravity of 0.85. The total weight of the wings when dry is so large that it will necessary to shorten the total methods of the airplane fuselage and adopt these of the biplane design. All forces, acting at a point, pass through a rotation center. In this case, as in a pin bridge, the forces are all applied to a large hollow bolt at the center of the wing box. In the design of the metal fitting, to reduce the moment

of wind needed, it was decided to employ a spar stiffener of steel of 300,000 lb per sq in tensile strength. The engine bearing arms, bulkheads, and plates are made of large diameter hot forgings.

Tail Structure

The tail structure is built up on the form of a biplane and is supported by three hollow bronze tubes of steel cable to make it as light as possible. The arrangement of the wings is such that the tail is well balanced with the wings, so that the tail is not loaded when the wings are in the horizontal position. The total area of the tail surfaces is 100 sq ft, and the horizontal stabilizer has a total area of 200.6 sq ft, and the elevator, 240.3 sq ft. The total area of the three surfaces is 60 sq ft.

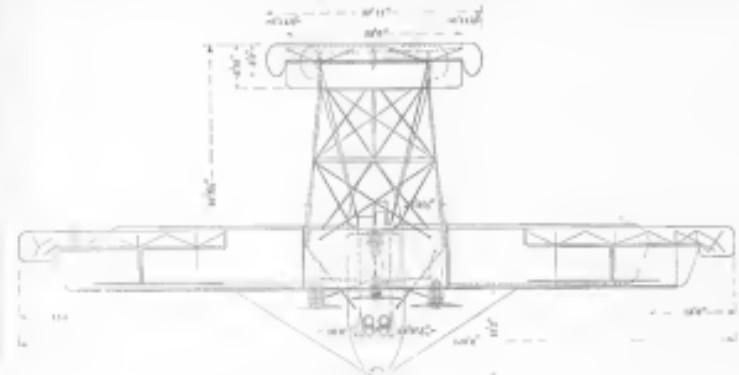
With this transmitter it is possible for the commanding officer to send messages from time to time regarding the

load of the aircraft weight only 45 lb, but is used for the regular telegraphic communication between the shipboard and stations up to a distance of 200 nautical miles. Since this is done by a propeller in one pair by steel cable, while airplanes are in flight. The antennas used for this set is a single trailing wire leading from the tail of the boat for a distance of 250 ft down and to the rear. A streaming load weight holds the rear end of the wire in position.

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One of the most important of the radio instruments on this ship is the radio compass. This consists of a set of revolving rods mounted in the tail of the aircraft, on which are mounted two sets of balanced copper wires. The radio waves are sent out on the ship, and by revolving the wires the radio signals obtained on two methods of connection are of the same strength.



PLAN VIEW OF THE NC 1 AT FIFTEEN WITH FOUR LOSENE ENGINES

progress, to the right, to be retrofitted by the nearest shore station to the Navy Department. Also communications can be held with destroyers or other craft and radio compass signals or other information required.

Radio Telephone

The other transmitter is a combined telephone and telegraph transmitter, and operates on a result 120-150 storage battery. It is used as an antenna consisting of wires previously stretched on the ship from the upper planes so that it may be used while the airplane is in flight or on the water.

It is this on which is used for telephoning between the shipboard and the flying officer so that the flying officer can call the shipboard or the flying officer can receive communications directly by telephone while the plane is in flight. Such telephone telephoning may be carried on up to a distance of 200 miles. While on the water this set may be used for telephoning or telephoning a distance of about thirty miles.

A special feature of the telephone set is the automatic switch, which is so constructed that the engine valves are not closed. This is accomplished by having the body of the telephone set mounted on a base which is so constructed as to be at the base of the diaphragm, and therefore the effect is neutral. The main water strike only the base of the telephone and even though the operator cannot hear his own voice, the radio set receives enough effect to modulate the transmitted wave.

The single set has the decided factor in success or failure in long distance transmission by telephone by wireless.

The operator then knows the direction of the incoming wave. By then reading the position of the wave on a scale on the radio, the bearing of the transmitting radio station to the ship is determined. The operator then informs the commanding officer of the incoming wave by means of the intra-communicating telephone, with means of telephone receiver held onto the helmet, and the same type of microphone used by the operator.

Using this same intra-communicating telephone system, the shipboard can telephone to the wireless, giving the necessary information in which to start the plane. He may inquire of the engine room regarding the condition of the engine, or be held radio telephone conversations with the navigating officer or one of the other officers.

In other words, the intra-communicating telephone makes possible regular communication between all sections of the ship, between the shipboard and the engine room, and the wind room, and in spite of the fact that they are located in separate parts of the ship. In addition to this the radio telephone makes it possible for the commanding officer and navigating to talk directly with each other, although their telephone may be fixed at a distance of 100 miles apart. The radio telephone signals may be received at from a distance of 200 miles, or from large land stations at a distance of 1,600 miles.

The radio receiving apparatus on the shipboard will pass no reception from land stations of high power at distances of several thousand miles.

The main striking fact regarding this radio equipment is that, completely installed, it weighs only 200 lb.



Front-and-Side Views of the Cab of the U. S. Naval Airship L-4. LAUNCH OF CAB, 40 HP. TWO HOSPITAL BEDS.
Photo 1. (Continued from previous page)

Course in Aerodynamics and Airplane Design

Part III.—Experimental Aeronautical Engineering

By Alexander Klemin

*Technical Editor, Aviation and Aeronautical Engineering, Consulting Engineer, Aviat. Mkt. Service, Consulting Aeronautical Engineer
(Corporation, 1929) by Alexander Klemin*

Section 5. Full Flight Testing

Physical Data for the Atmosphere—Full flight testing may have one of two objects: first, the routine testing of a new airplane for speed at different altitudes, climb, visibility and maneuverability; second, research testing for purposes of aerodynamics investigation. We shall confine ourselves to a discussion of research performance in this paper. Even though performance testing involves the possibility of noisy errors, and requires great care and, above all, standardized methods,

from this also follows the useful equation

$$\frac{D}{D_1} = \frac{P_1 T}{P T_1}$$

The equation $D = \frac{P T}{D_1}$ can be expressed in a number of ways.
(a) Density in grams per cubic meter.
Density of air at 0 deg. Cent. (or 32 deg. Fahr.) and 760 mm.



FIG. 1

It is clear that temperature may be used between points at different altitudes.

Formula for Density of Air—For a perfect gas, $PV = RT$ is a fundamental thermodynamic law, where P = pressure in suitable units, V = volume of unit weight, R = a constant, and T = absolute temperature.

From this it follows that

$$\frac{P}{T} = \frac{R}{RT}$$

and since $\frac{1}{V}$ = density at appropriate units,

$$D = \frac{P}{RT} = \text{density formula for all gases.}$$

Or, to make convenient form,

$$D = \frac{P C}{T} \text{ where } C = \frac{1}{R} = \text{some constant.}$$

(at 29.92 in. Hg. equals 2262.6 gm. per cu. m.
Standard density of air at 0 deg. Cent. (or 32 deg. Fahr.) and 760 mm. = 1.225 gm. per cu. m.)

$$1. \quad D_{100} = \frac{P_1 \times 463.39}{T_1}$$

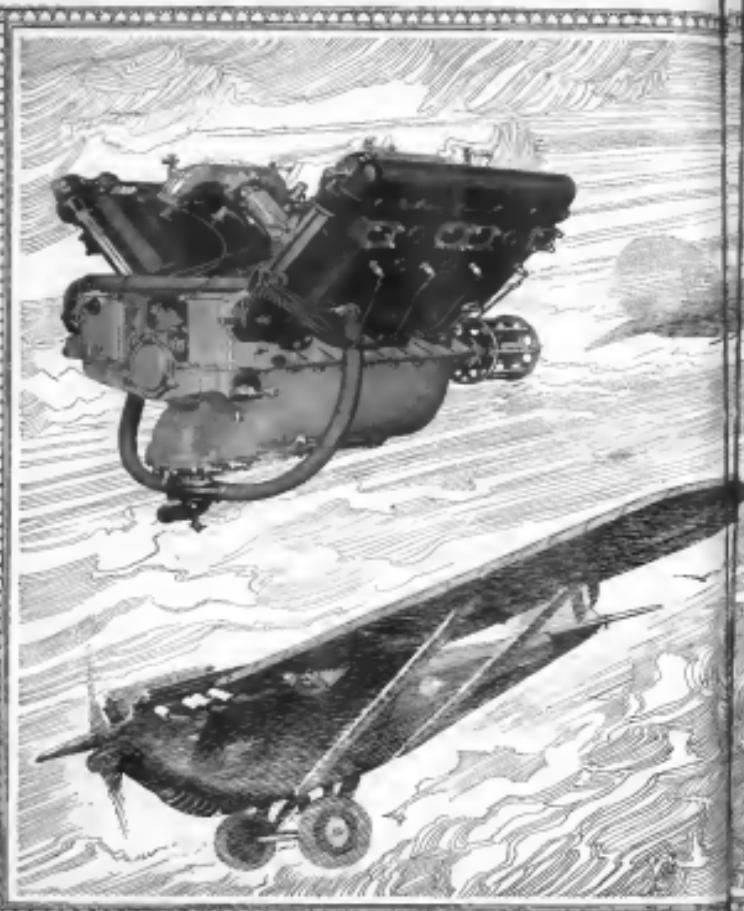
where P_1 = pressure in millimeters of mercury at 0 deg. Cent.
 T_1 = absolute temperature in deg. Cent.

$$2. \quad D_{100} = \frac{P \times 31785}{T}$$

where P = pressure in millimeters of mercury at 0 deg. Cent.
 T = absolute temperature in deg. Cent.
 $=$ reading on Centigrade scale + 273 deg.

$$3. \quad D = \frac{P \times 21230}{T}$$

where P = pressure in inches of mercury at 0 deg. Fahr.
 T = absolute temperature in Fahr. scale
 $=$ reading on Fahr. scale + 459.6.



"The Motor that made the Speed possible."

TWO conspicuous examples of the merit and reliability of aeronautical engine performance, see instances in the

HISPANO-SUIZA AERONAUTICAL ENGINE

installation, in the famous Loening and Voigt seaplanes, designed primarily to allow the full expression of this remarkable engine's individuality in both the 300 and 180 horse-power types.

Wright-Martin
Circus Corporation
New Brunswick, N.J.

Approved by Bureau of Standards

where 1, and 6, are in C.R. or Fahr units, and 1, is 253 in C.R. units and 420.4 in Fahr units.

Graphs of the chart in Fig. 6 show that, if a direct measure with the angle, β , is impossible to measure the distance, b , between two altitudes where the distance is not too great, it is sufficient to measure the temperature difference between the two altitudes. In finding altitudes of several thousand feet where temperature is recorded at different altitudes, the differences are computed at these intervals and sufficient data points are obtained. In Fig. 6 a correction chart for temperature is given.

Because of atmospheric adiabatic pressure curves, if T is the vapor pressure of water in the atmosphere, expressed in the vapor units as P , then when P is calculated from values of T

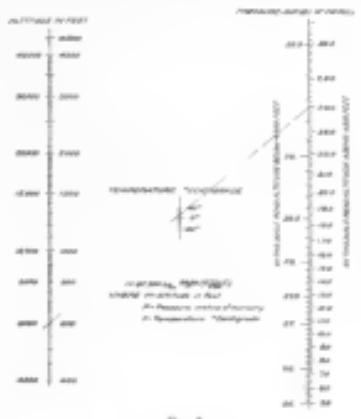


FIG. 7

instead of P the expression $P = 0.2377 T$ is employed. This is a very good approximation. In the Bureau of Standards atmospheric pressure curve (Fig. 5) it is shown that these two curves coincide. This curve is used to get the necessary calculations of altitudes and barographs, which are always calculated for a temperature of 50 deg Fahr.

The modified Baily formula for this curve is

$$P = 0.2377 \log \frac{P_1}{P_2}$$

and the values for the curve are given in table III. Hence for any altimeter map parallel to a pressure temperature, the pressure temperature to any altitude can be calculated at once.

Altitude Chart for Adiabatic.—In Fig. 7 is given an altitude chart for altitudes based on the formula

$$H = 0.0200 \log \frac{P_1}{P_2}$$

at an adiabatic temperature of 39 deg Fahr, or 50 deg Fahr, and the temperature conversion of

$$127.34$$

deg Fahr.

This chart would hold absolutely true for high altitudes when the temperature is a constant throughout. It is approximately true if the temperature is constant between the two extremes it is valid. It is almost exactly true if differences of altitude are sought and these differences are small.

To use the chart it is only necessary to lay a straight edge across it diagonally through the current pressure and temperature points, the reading where the straight edge crosses the altitude scale is the corresponding height. A piece of fine oil

TABLE II
Altitude Points for Adiabatic
 $T = 40$ Deg Fahr

Altitude	Pressure Pounds per square in.	Temperature Degrees Fahr.
0	1000	40
1000	990	39.99
2000	980	39.98
3000	970	39.97
4000	960	39.96
5000	950	39.95
6000	940	39.94
7000	930	39.93
8000	920	39.92
9000	910	39.91
10000	900	39.90

thread rapidly stretched between the thumbs forms a very convenient straight edge. The altitude scale is graduated to read heights from 4000 to 40,000 ft. on the altitude scale and from 400 to 4000 ft. on the scale edge. The pressure scale is graduated both sides to correspond with the altitude scale. It is necessary, in reckoning that whatever the pressure has on the scale side the correct altitude will be found on the scale edge also.

Aeronautical Patents

Patent Number 1,049,618

1,049,618.—To John F. Kline, Brooklyn, N. Y. Flying Machine, for a new and improved Flying Machine, Patent No. 1,049,618, issued January 10, 1913, to the Commissioner of Patents.

1,049,619.—To Charles E. Waller, Philadelphia, Pa. Airplane, Patent No. 1,049,619, issued January 10, 1913, to the Commissioner of Patents.

1,049,620.—To Pierre Pichot, Paris, France, and to Joseph Pichot, Paris, France, both Frenchmen, Patent No. 1,049,620, issued January 10, 1913, to the Commissioner of Patents.

1,049,621.—To Ernest Richard Caldecott, London, England, and George F. Caldecott, London, England, Patent No. 1,049,621, issued January 10, 1913, to the Commissioner of Patents.

1,049,622.—To Mervin R. Curtis, Springfield, Mass., an airplane, Patent No. 1,049,622, issued January 10, 1913, to the Commissioner of Patents.

1,049,623.—To John F. Kline, Brooklyn, N. Y. Flying Machine, Patent No. 1,049,623, issued January 10, 1913, to the Commissioner of Patents.

1,049,624.—To Frederick G. Whittle, Great Yarmouth, England, Patent No. 1,049,624, issued January 10, 1913, to the Commissioner of Patents.

1,049,625.—To Ernest F. Wittenberg, New York, N. Y. Flying Machine, Patent No. 1,049,625, issued January 10, 1913, to the Commissioner of Patents.

1,049,626.—To George W. Smith, New York, N. Y. Flying Machine, Patent No. 1,049,626, issued January 10, 1913, to the Commissioner of Patents.

1,049,627.—To Ernest W. Smith, New York, N. Y. Flying Machine, Patent No. 1,049,627, issued January 10, 1913, to the Commissioner of Patents.

1,049,628.—To William L. Cope and Nathan H. Tuck, Jr., Bothwell, N. Y. Airplane, Patent No. 1,049,628, issued January 10, 1913, to the Commissioner of Patents.

1,049,629.—To Charles E. Waller, Philadelphia, Pa. Flying Machine, Patent No. 1,049,629, issued January 10, 1913, to the Commissioner of Patents.

1,049,630.—To Ernest W. Smith, New York, N. Y. Flying Machine, Patent No. 1,049,630, issued January 10, 1913, to the Commissioner of Patents.

1,049,631.—To Ernest W. Smith, New York, N. Y. Flying Machine, Patent No. 1,049,631, issued January 10, 1913, to the Commissioner of Patents.

1,049,632.—To William L. Cope and Nathan H. Tuck, Jr., Bothwell, N. Y. Airplane, Patent No. 1,049,632, issued January 10, 1913, to the Commissioner of Patents.

1,049,633.—To Charles E. Waller, Philadelphia, Pa. Flying Machine, Patent No. 1,049,633, issued January 10, 1913, to the Commissioner of Patents.

Test of U.S.A.F. Bodies

At about 5,500 ft. above the ground, the Bureau of Standards made a test of the U.S.A.F. bodies. The bodies were made of solid, gray skin, with laminated skin and leatherette (Fig. 5). The outer skin on the halfbodies was alternately of skin and cloth, while the one side was skin on one side, and the other side was leatherette and leather on one side. The skin was 0.015 in. thick, and the leatherette was 0.012 in. thick. The leatherette was 0.012 in. thick, and the leather was 0.015 in. The number of laminations ranged from three to seven, with the outer skin in all cases laminated. The number of laminations in the halfbodies ranged from seven to thirteen, with a total thickness of from 1/2 to 1 in.

The weight of the complete body was 380 lbs, asperated as follows:

Material	Thickness	Weight
Outer skin	0.015 in.	140.0
Leatherette	0.012 in.	134.8
Leather	0.015 in.	134.8
Bottom	0.015 in.	14.8
Front	0.015 in.	14.8
Total		380.0



FIG. 5 WOMAN U.S.A.F. FUNDAL SET UP FOR TEST

Up to a load factor of 7 this body showed no signs of failure except for a slight wrinkling of the skin on the bottom membrane at front of the rear shoulder. At this load factor a slight loss of the front shoulder was noticed, but it did not fail by stretching out the skin with holes. Owing to this local failure it is impossible to say how much greater load this body could have withstand. Under general failure would have occurred. There was, however, no failure at any of the joints, which were long-term pressure joints, and the joints of the skin panel were not stressed, probably having a greater tensile strength than the skin or cloth and popular laminations of the outer skin which were tested subsequently.

At the rate of failure the total load on the body supports was 22,000 lbs., or about 480 lb. on the front support and 180 lb. on the rear, giving an equivalent load of 60.36 per sq. in.

Patent No. 1,049,632, Type No. 2.—This is the first of a series of seven bodies made by the Bureau of Standards for the U.S.A.F. two-seater fighter plane, giving a horizontal and vertical crosshatch.

The front panel had seven skin plies with the grain long, laminated, and had layers of cotton fabric between all plies. As in the previous type, the front panel had the skin, strengthening the body, and ranged from two to three plies with a total thickness of from 1/2 to 1 in. It was covered to the halfbodies and bottom with cloth and glass.

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as thick as eleven-ply 1 in. thick. It is noteworthy that the longitudinal webs were very nearly in line with the sole of the hull. It is also noteworthy that there was no consistency of action of the shear stresses and no exceed failure in any one of the USCB-1 bodies previously tested.

The longitudinal webs identical with those of the previous type. In all cases the central face of the longitudinal web was next to the skin.

The body withstood a dynamic loading of 7.5 before final failure occurred and that proved of very satisfactory strength, as compared with previous examples, which is attributed to the elimination of local weaknesses, the distribution of the longitudinal webs, and the lack of failure between the plies of the skin. There were signs of cracks in the skin and wrinkling of the skin long before failure occurred, but the latter is much less serious in a body having a layer of fabric between the plies of the skin, the fabric providing considerable protection against splitting.

Device Petman USXB-1 Type No. 3. This body was practically identical with the previous model, with the exception of the following essential structural changes.

The bottom and the skin from stations 1 to 19 (Fig. 8) were of sheet-ply spruce 1/2 in. thick, overall, with an infill between the plies. The top plies in this portion were 1/2 in. thick with longitudinal grain, while the core was 1/2 in. thick with transverse grain. The skin in the rear portion of the

longitudinal stresses at that point. These stresses increased with the area increased of load and under a factor of 7 the upper longitudinal webs of stations 7 and the skin failed due to fatigue.

The test showed that the inclusion of failure between the plies slightly reduced the strength of this body, for the Device Petman Type 2 body had a lighter skin throughout than Type 2 and also had a smaller total weight, yet it developed a higher strength than the third body, which is highly inaccurate.

ACKNOWLEDGMENT

As part of the above tests on various types airships, both the following paragraphs are intended to give the reader some information which he will find useful for the use of aircraft designers.

(1) The upper skin should be made with a large proportion of longitudinal grain, transversely and with the face plies of hardwood.

(2) The use of mid-long grain (not severely striped) is undesirable.

(3) The stiffening of the center skin with the longitudinal stiffening of bulkheads is not at all efficient, especially strong bulkheads are not required to support the pressure of the gas.

(4) The use of mid-long grain by bulkheads, the bottom of the skin has a decided compression value, consequently it is important to use extremely strong lower longitudinal webs.

(5) The skin is considerably strengthened by the use of center stiffening between the plies.

(6) Care should be exercised to see that the joints or splices



FIG. 7. DRAWINGS OF DEVICE-PETMAN USXB-1 BODY NO. 1

(a) Where properly stiffened the skin of the skin has a decided compression value, consequently it is important to use extremely strong lower longitudinal webs.

(b) The skin is considerably strengthened by the use of center stiffening between the plies.

(c) Care should be exercised to see that the joints or splices



FIG. 8. ASSEMBLY DRAWING OF THE USXB-1 VENICE FUSELAGE

body was 1/2 in. thick, consisting of outside plies 1/2 in. thick with longitudinal grain and a core of 1/2 in. thickness with transverse grain.

The top longitudinal webs were 5/8 in. and 7/8 in. thick, made of sheet-ply wood, while others were 1 in. in thickness, made of sheet-ply. The bulkheads at stations 7 formed the points of attachment for the 5/8 in. webs, and essential stiffening strips were fastened to the bulkheads, varying from 2 in. at the front to 5 in. in the rear portion.

The longitudinal webs were 1/2 in. apart from stations 1 to 9, and of spruce in the rear sections, while the lower longitudinal webs throughout were spruce.

Under a dynamic loading of 6.5 longitudinal cracks commenced to show in the skin near station 7, going across

in the skin do not occur at points of great stress.

(7) The upper longitudinal webs should be strengthened at out-with stations 1 to 19.

(8) Bulkheads should be so designed that they will stand up well under local reactions and bending moment applied by the M.I. wire.

(9) Very careful manufacture should be maintained in order to insure good uniform results.

(10) Care should be taken in the design of the skin.

For the benefit of aircraft designers a general assembly drawing of a typical center fuselage for the USXB-1, or British type center fuselage, is illustrated in Fig. 8, with the principal dimensions and dimensions of stations. All station numbers in the description of the USXB-1 refer to this drawing.

Tailoring of Airship Envelopes

By R. H. Upson

1 consideration of interest has developed with regard to that necessary as related to the established American practice of "tailoring" non-rigid envelopes, which gives them certain advantages usually thought peculiar to rigid envelopes without getting the desired commercial value. This article does not do the work of a panel of particular interest, but it is a mathematical exercise, with the theory of similar materials and static design in general, but simply sets forth some basic relations underlying this subject.

As a rule it is necessary to tailor a non-rigid envelope unless the gas pressure is to be increased to a point where the envelope can point along the tang. If correctly calculated, this can be done by adjusting the following items in correct proportion:

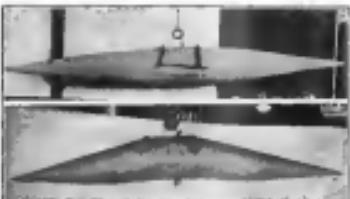


FIG. 1 (TOP) AIRSHIP MODEL INFLATED WITH AIR
FIG. 2 (BOTTOM) THE SAME, FILLED WITH WATER

Size and shape of envelope, length and weight of gas, character of gas, gas pressure, size and weight of envelope, size and position of bulkheads, weight and location of gas, gross weight and position of strained power plants, gasogene tanks, etc.

But tailoring can often be disadvantageous, as, for instance, when the general design and purpose of the ship brings the various components into such a position that the tailoring would result in an appreciable good envelope, too large for the purpose. This allows, however, a very limited choice in the position of various items, such as car, fin, ballast, fuel tanks and fuel cells. These requirements are different for almost every different design of airship, and in a few cases they do work out satisfactorily in a distribution of load which in itself eliminates distortion or the gas tang.

When the load-carrying materials are not distributed uniformly along the gas bag a rigid envelope will hold its shape, but a gas bag will not hold its shape unless the load is uniformly distributed over the entire surface, as shown in the accompanying illustrations. This is a small water model, made of parallel tubing to show better how it distorts. Fig. 1 shows the model inflated with air, while Fig. 2 shows the same model inflated with water and the photograph turned upside down to illustrate the appearance of the gas-filled balloon.

The parallel tubes are practically as resistance to shear, hence the generalized double b-spline curve which is formed. Then the skin of the airship is longer compared to that of the rigid envelope, so that the envelope is longer, and the envelope is longer, so what would be expected from the force of gravity, also, in the state of distortion the length of the top curve from point to point is approximately the same as that of the bottom curve. If the top had no strength, the top and bottom would be parallel, but as the top has strength, the top would not look very different. This is approximately the kind of curve assumed by the early Lehman designs in France (which were built of parallel tubes), and in a loose and moderately degree to an airship tailing with a single eye.

The proper amount of tailoring in Gasdyne airships is determined:

(a) By water model tests showing the amount of distortion necessary to be overcome.
(b) By correlation based on the form of the first model of any new series.
(c) By a comparison based on observation of similar types of ships and a comparison of bending moments.

The tailoring is done by cutting out "P" shaped vertical strips from either the top or bottom of the balloon on both. It is found to experience that these strips may be as wide as 1 in. and as high as 1/2 in. approximately, and that the tailoring, the effect of such practice, however, is small. Gasdyne strips should be so made to coincide on strips of 3 in. maximum width.

The final form may be set down as follows:

(a) The envelope must be symmetrical in shape to keep the resistance down to a minimum.
(b) To get the maximum gas possible to the maximum.
(c) To produce a balloon which is straight and neat in appearance.
(d) To keep the fabric stresses within proper limits.

Once an envelope is properly inflated it will hold its shape on the average, indefinitely. The tailoring is based on the usual assumptions as regard to cable adjustments, air in ballasts, fuel in tanks, etc. Variations in the shape are bound to occur due to the various gas pressures and temperatures, and to reorganization of the balloon. That these variations should be kept within limits by the very numerous approximations of all envelope which have been built to standard specifications. In the design of new ships it has been found better to err in getting the tail a little too long than a little too short, and that the tail may always be made of parallel tubes, a closed curve being the tail. In addition it is recommended that the height of the tail and the angle of the tail be two different things, which must often be handled in different ways.

Flight License Compulsory

The Joint Army and Navy Board on Aeronautic Cognacess sends to each member an inventory of model data, the number of which is to be determined by the number of members.

On March 26, 1929, during the grandiose celebration of the hundredth year of the 25th Division in New York City, a dirigible was seen in flight directly up and down Fifth Avenue, to the great surprise of a changeover from altitude to the ground. In the effort to determine the cause of the accident, it was found that the envelope had been partially ruptured, so that in case of failure the pilot would have had no chance except to land in the rear of the aircraft. It could have crashed into a group of Central Park trees in the absence of trees.

It was developed that this boat was piloted by a civilian who was flying without the license required by the Proclamation of the President of the United States on February 26, 1928. The proclamation provides that a license must be obtained from the Joint Army and Navy Board on Aeronautic Cognacess by or before the 1st of May of each year for any aircraft, dirigible, airship, seaplane, or other machine or device over the whole United States, the Territorial Waters, Tropic of Cancer, and the Panama Canal Zone. Heavy penalties are attached to violation of these regulations.

These are in a way of additional protection for the public safety, which is of great interest, and which may also be of great assistance to people. In case of accident a pilot would be forced to descend immediately, and human life and property would be endangered to a certain degree. All present airtight civilian aircraft are subjected against the repetition of an accident, and the same is true of the 25th Division. March 26, 1929, and are warned that before engaging in the operation of any airship or balloon, they must first receive a license from the Joint Army and Navy Board on Aeronautic Cognacess.



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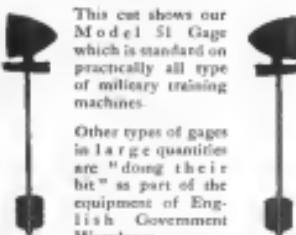
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"You are welcome to the schoolhouse to debate all
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frightful speed of fifteen miles an hour, by steam,
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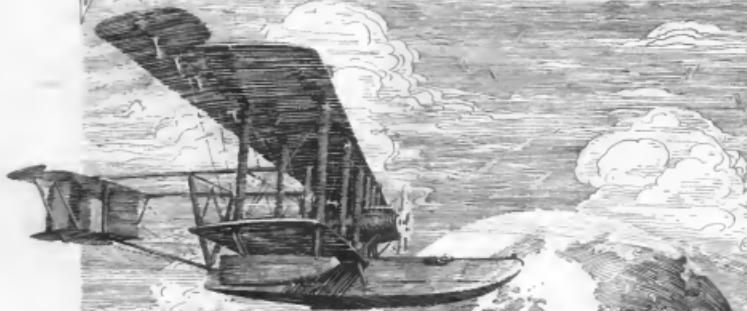
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